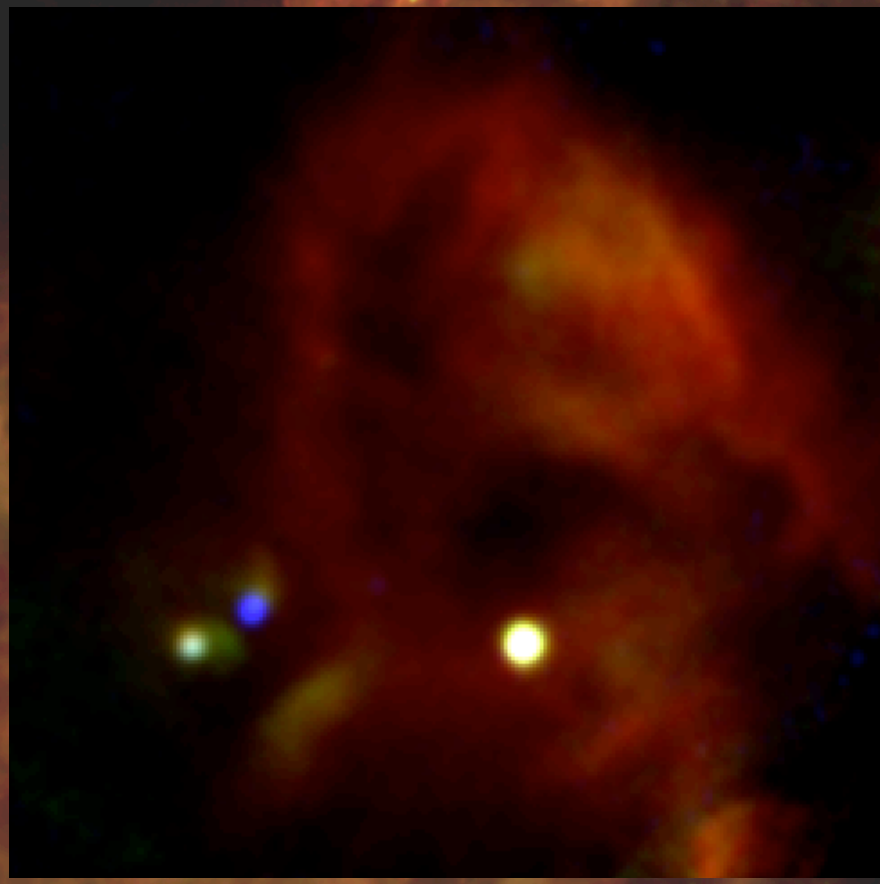
Mid-infrared Imaging Of The W40 Star Forming Region Using SOFIA-FORCAST



SOFIA Community Task Force Tele-Talk
25 April 2012

R. Y. Shuping *(Space Science Inst./USRA-SOFIA)*

SPACE SCIENCE INSTITUTE

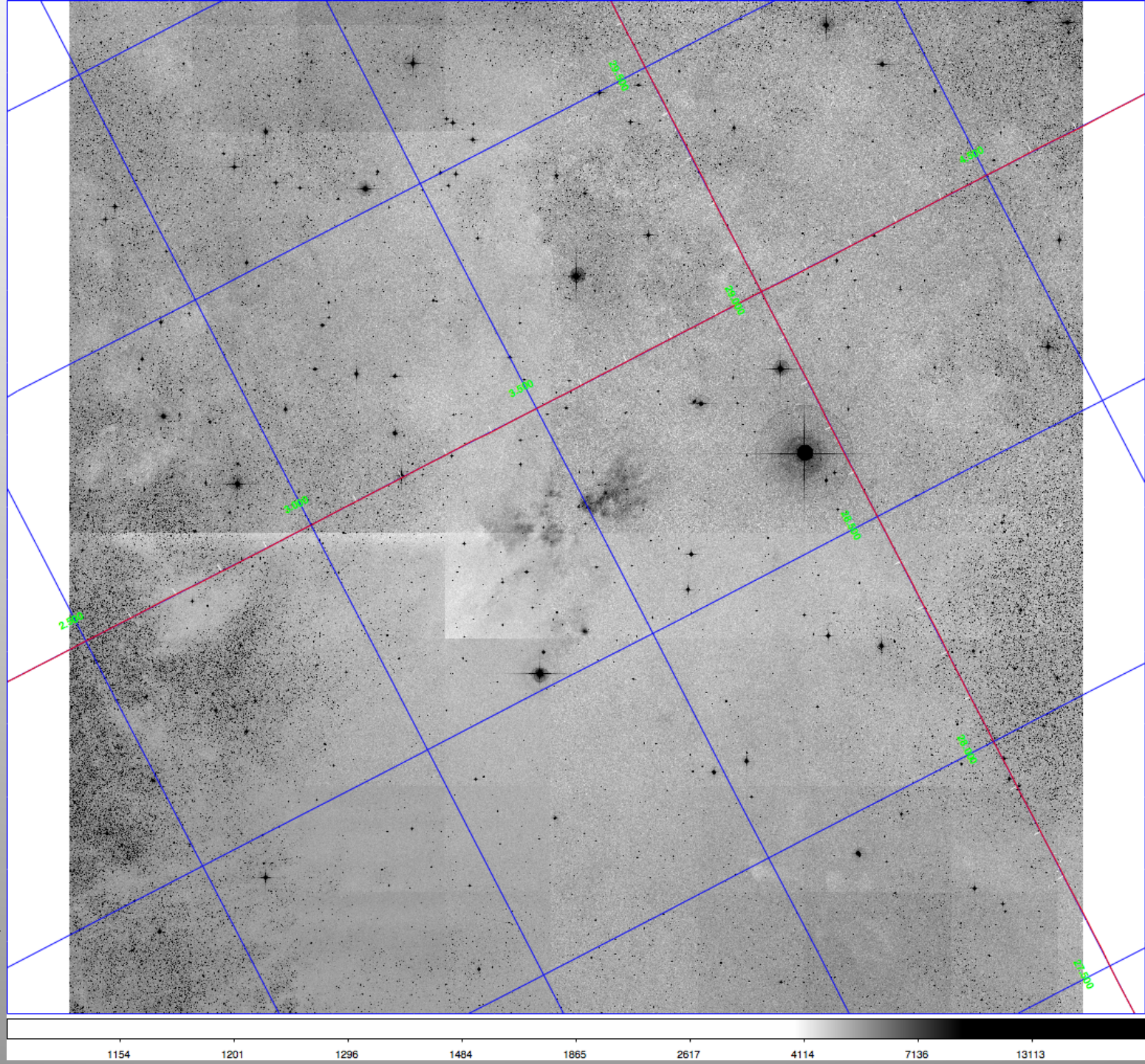
SOFIA Stratospheric Observatory for Infrared Astronomy

USRA

W40

DSS (R)

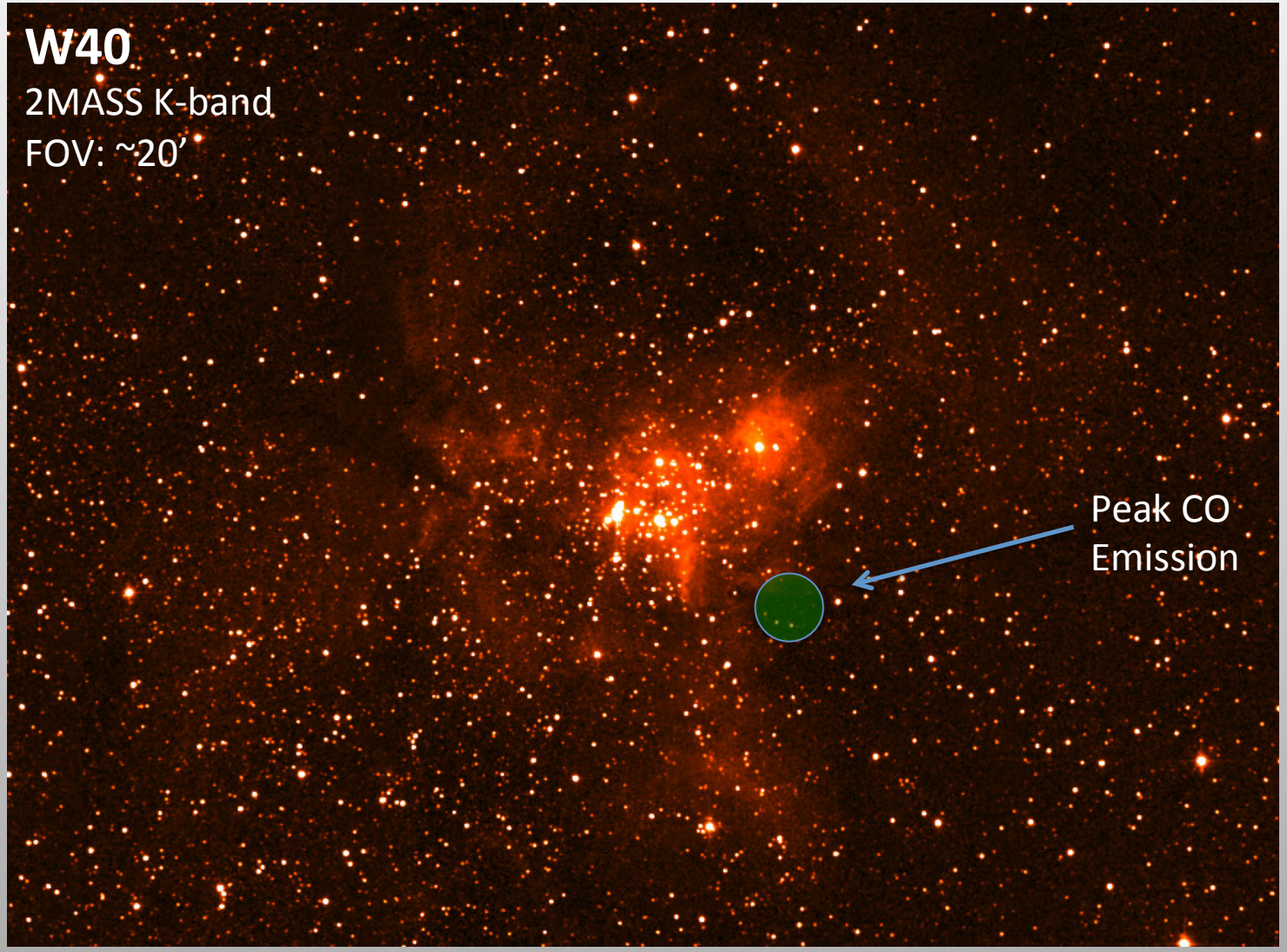
FOV: 2°



Radio Continuum:

LyC = 1.5 x 10^{48} s^{-1}

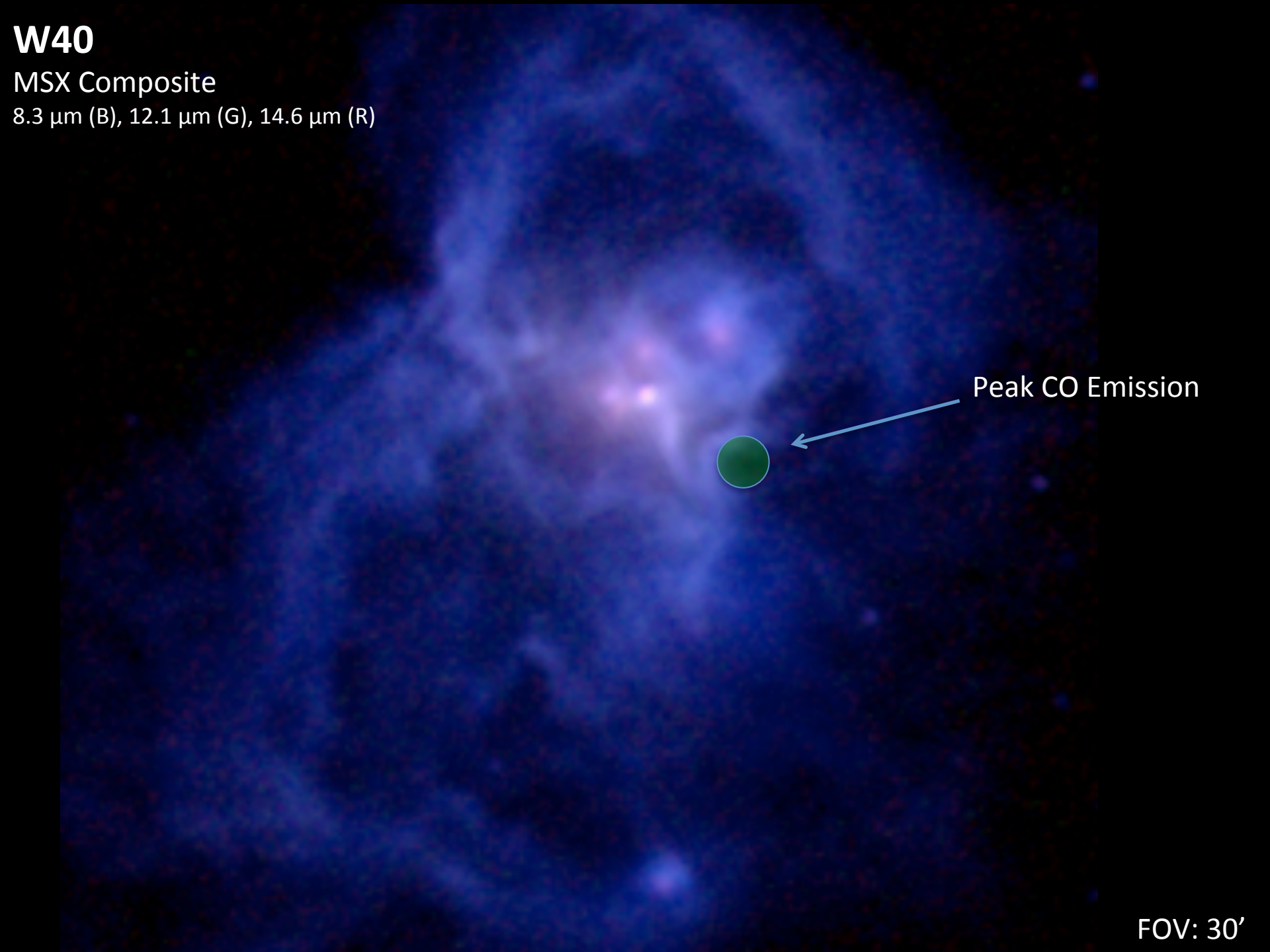
(Late O)



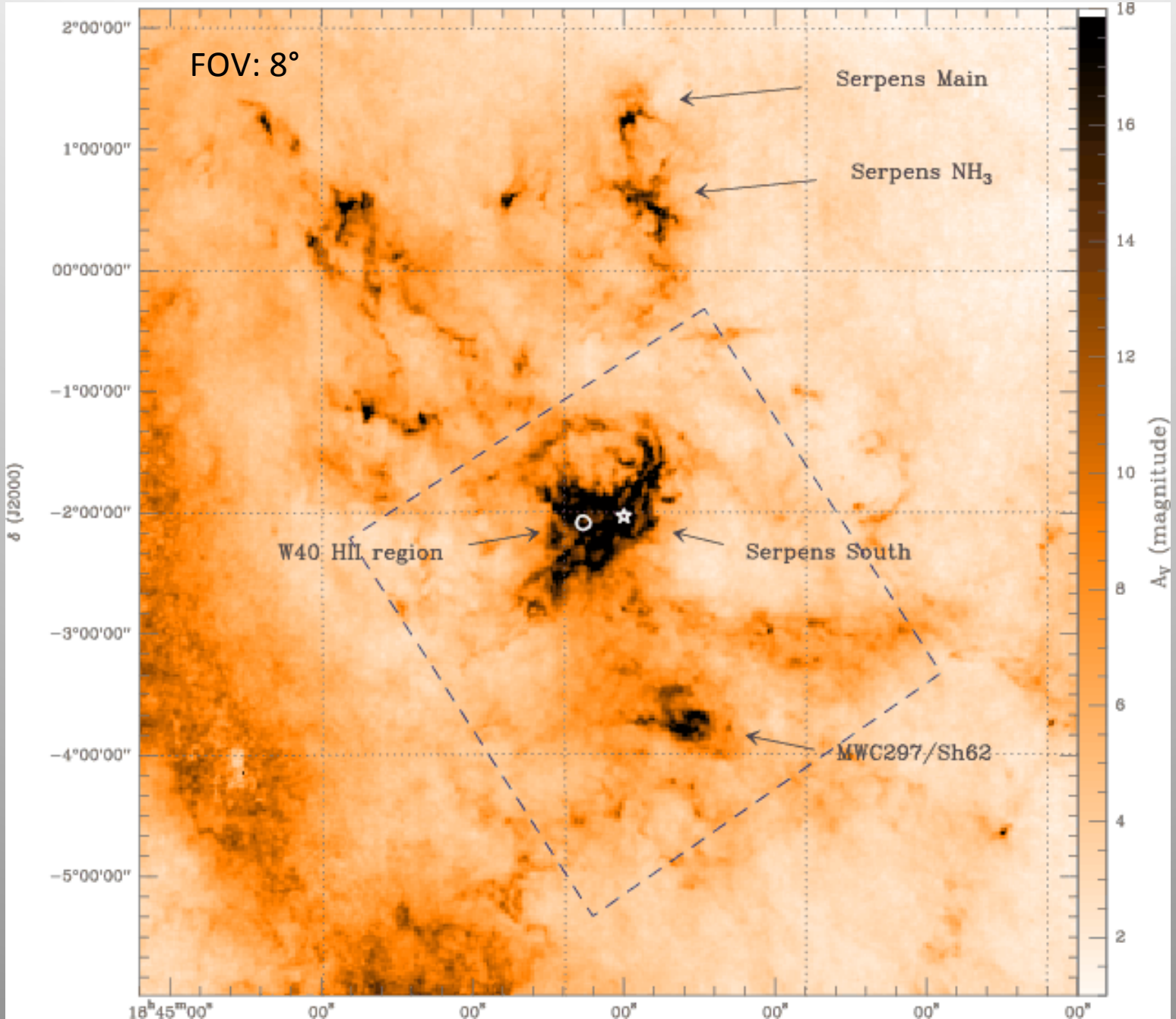
Chandra X-Ray Survey (Kuhn et al. 2010):

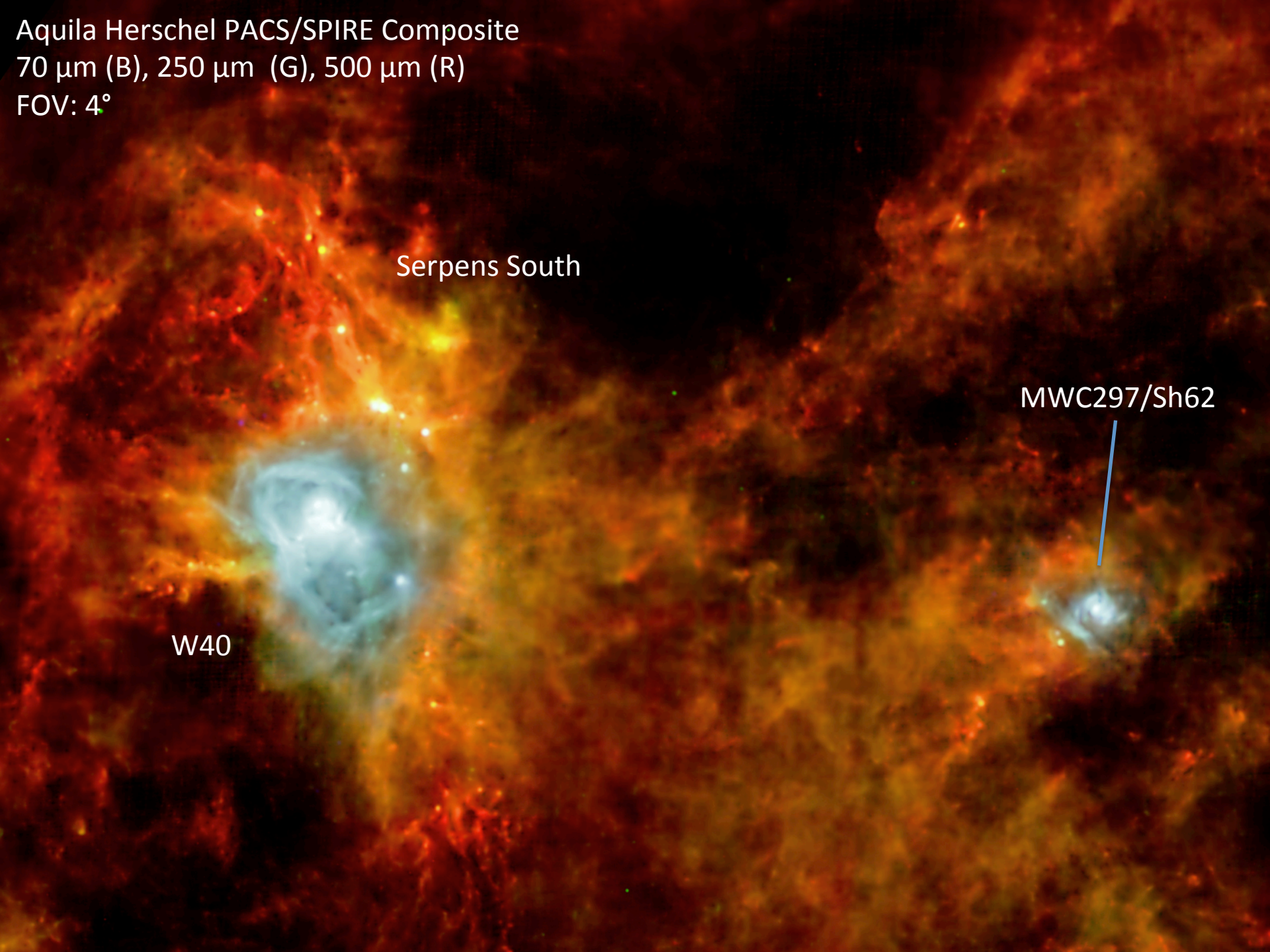
- ~200 X-ray sources in 17' FOV
- Total cluster population: 600 members
- Disk Fraction: >50% (K-band excess)
- Cluster Age: <1 Myr (but see Lada & Lada 2003)
- Distance: ~600 pc

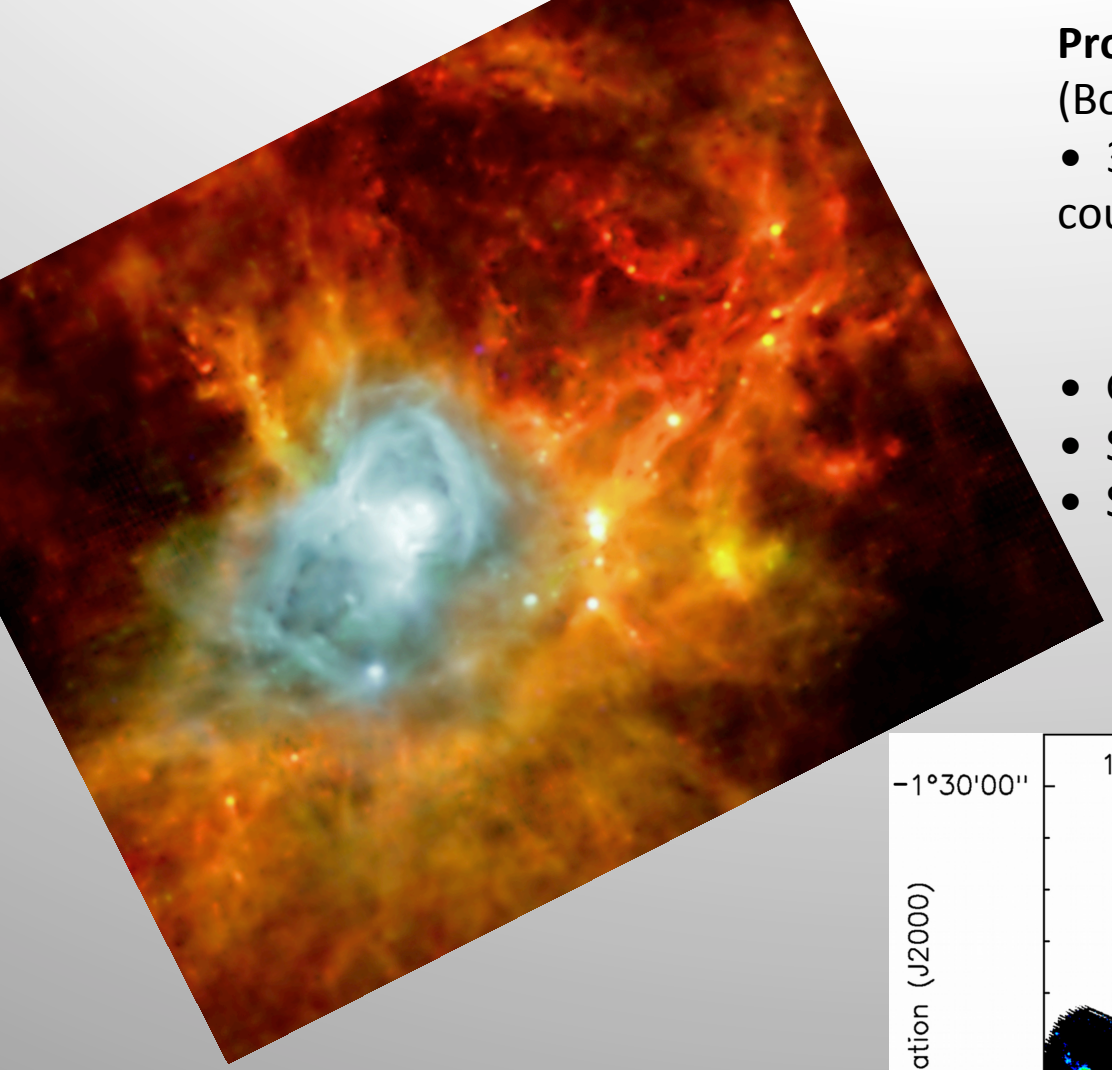
Brightest near-IR sources first studied by Zeilik & Lada (1987) and Smith et al. (1985).


W40
MSX Composite
8.3 µm (B), 12.1 µm (G), 14.6 µm (R)
Peak CO Emission
FOV: 30’

2MASS extinction map of the Aquila Rift (Bontemps et al. 2010).




Aquila Herschel PACS/SPIRE Composite
70 µm (B), 250 µm (G), 500 µm (R)
FOV: 4°
Serpens South
MWC297/Sh62
W40

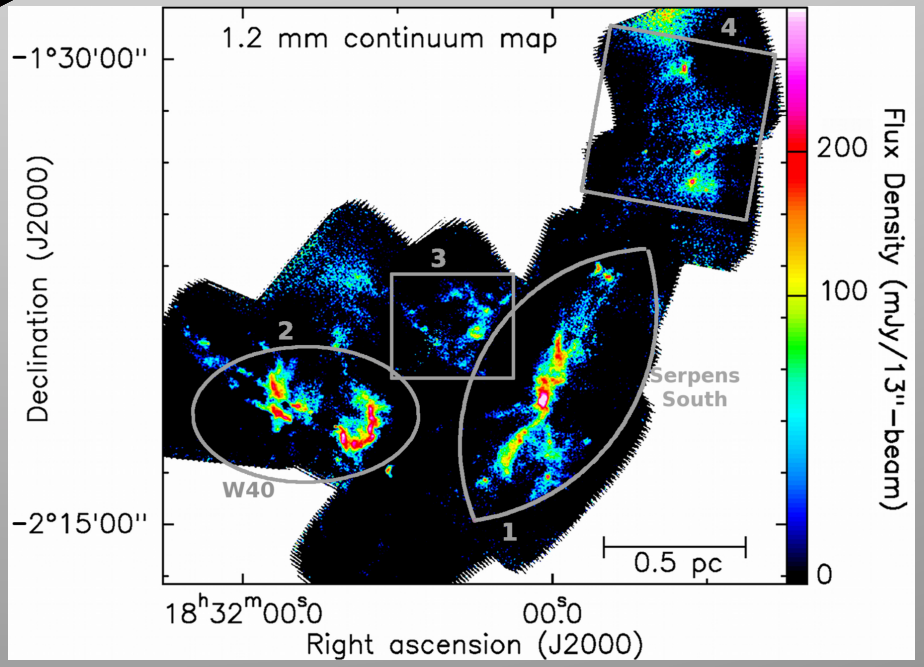


Protostars in W40

(Bontemps et al. 2010, Maury et al. 2011)

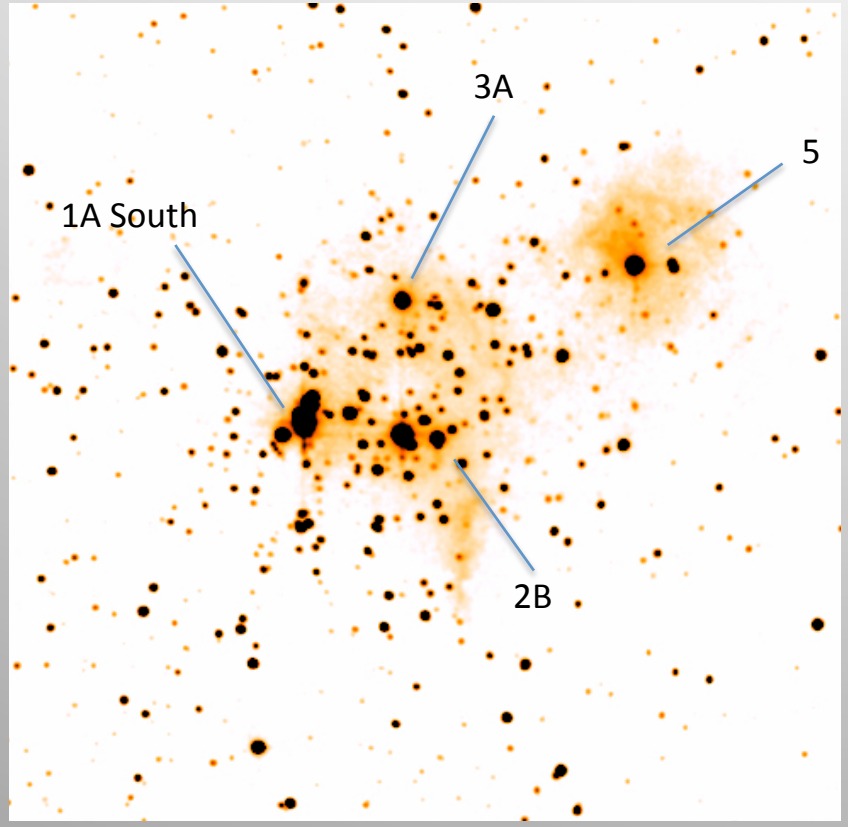
- 36 mm sources w/ Herschel counterparts
  - § 16 starless cores
  - § 20 Class 0 and 1
- Gas Mass: 310 $M_\odot$
- SFE: ~15%
- SFR: > 35 $M_\odot$ Myr^{-1} pc^{-2} (burst?)

But SFR is too high due to adopted distance of 260 pc!

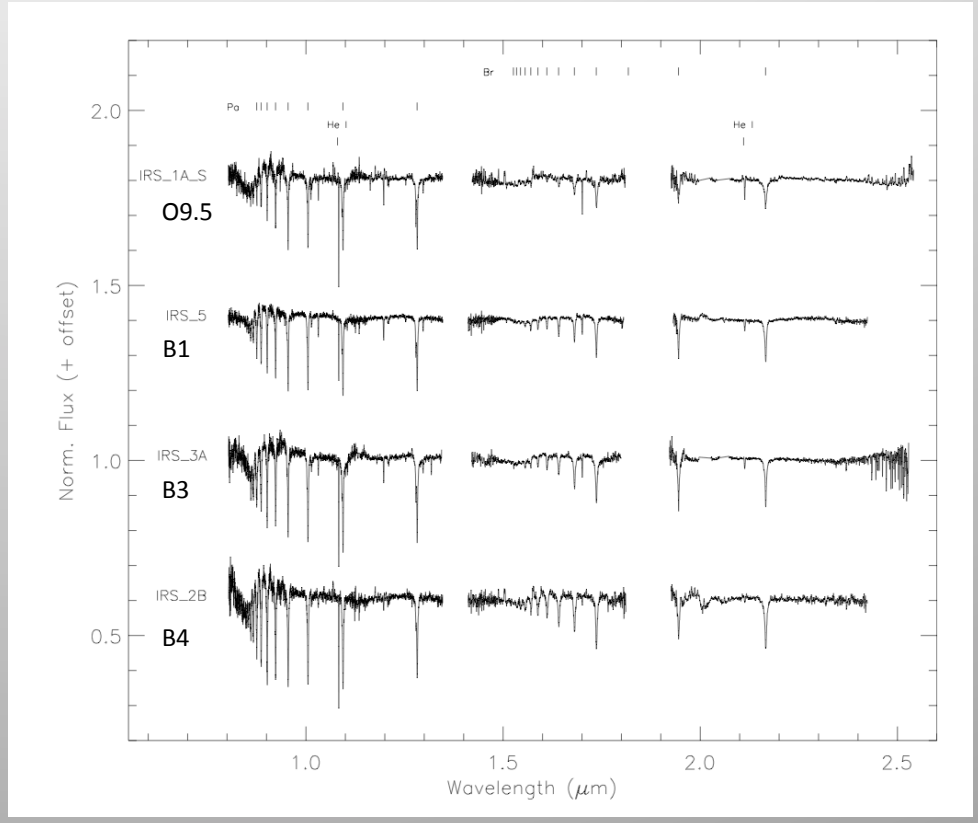


Observed protostars are second generation, initiated by expanding bubble from O-star winds.

Near-IR spectra of the brightest members of the W40 cluster
(Shuping & Vacca et al., in prep)



Main Sequence Stars:



Results:

- 1 O9.5 and 3 early-B stars
- 2 Low-Mass YSOs, 2 HAeBe's
- Distance: ~500 pc (+/- 50 pc)
- Age: < 7 Myr
- IRS 1A South (O9.5) appears to be the dominant energy source.
- Strong He I (1.083 μm) absorption -> binaries

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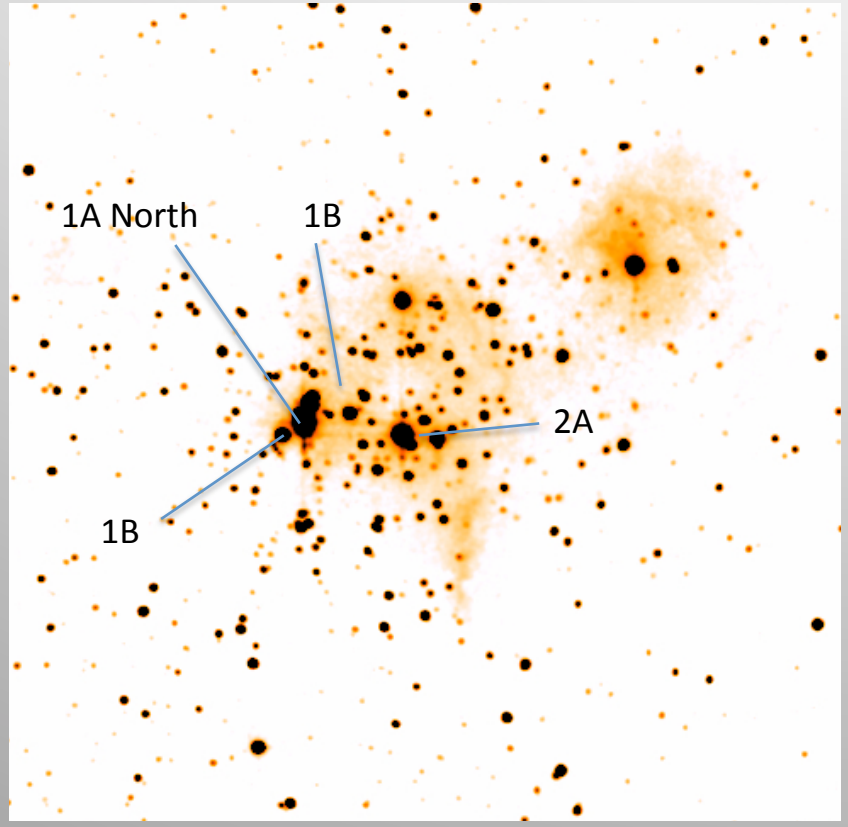
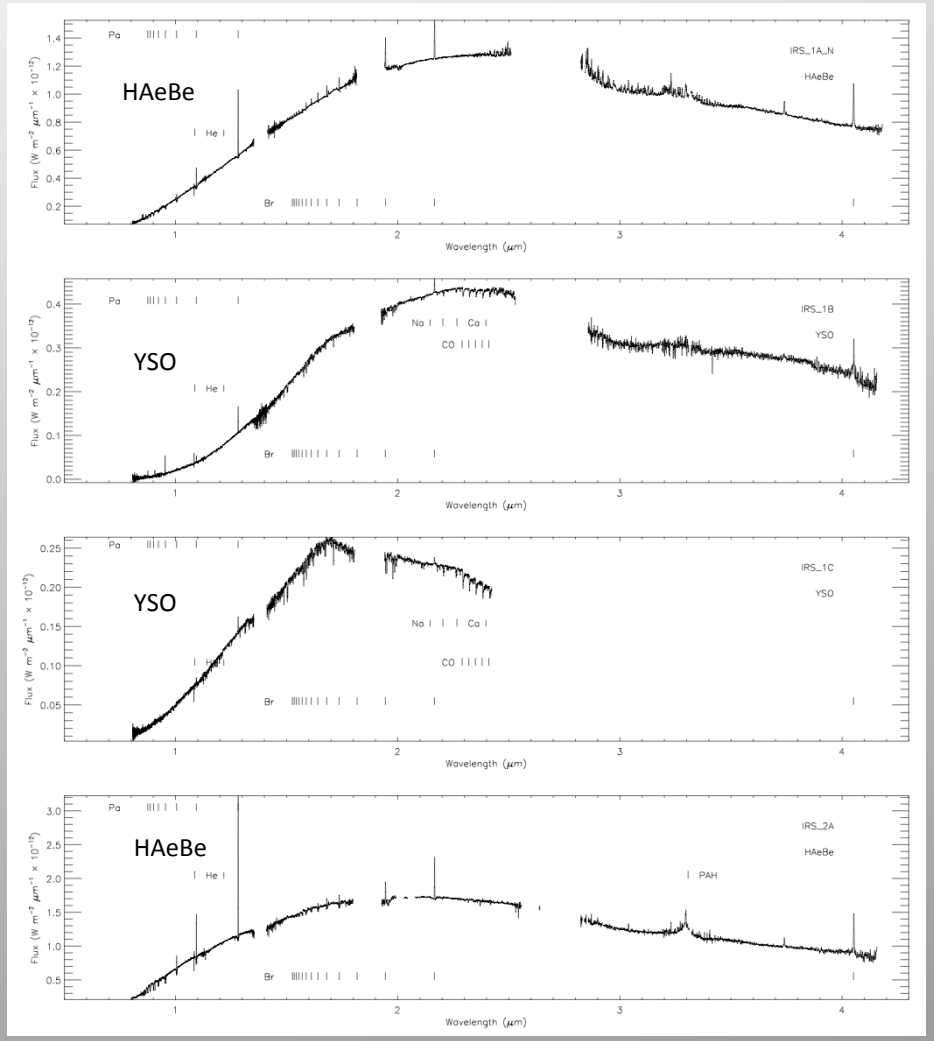


Young Stellar Objects:



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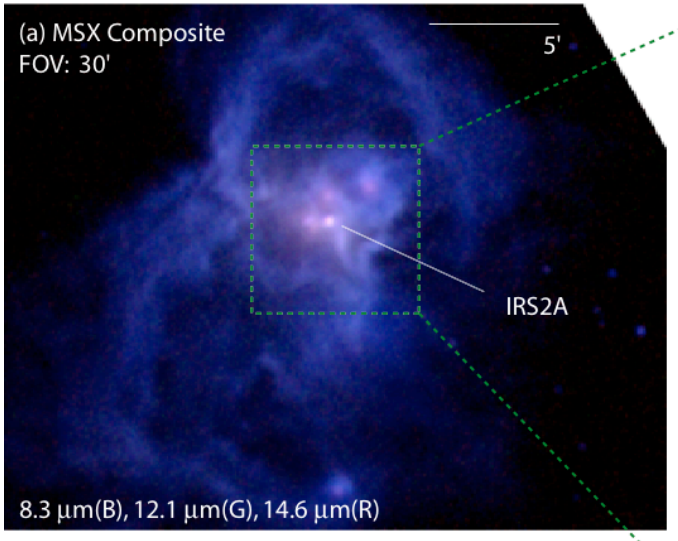
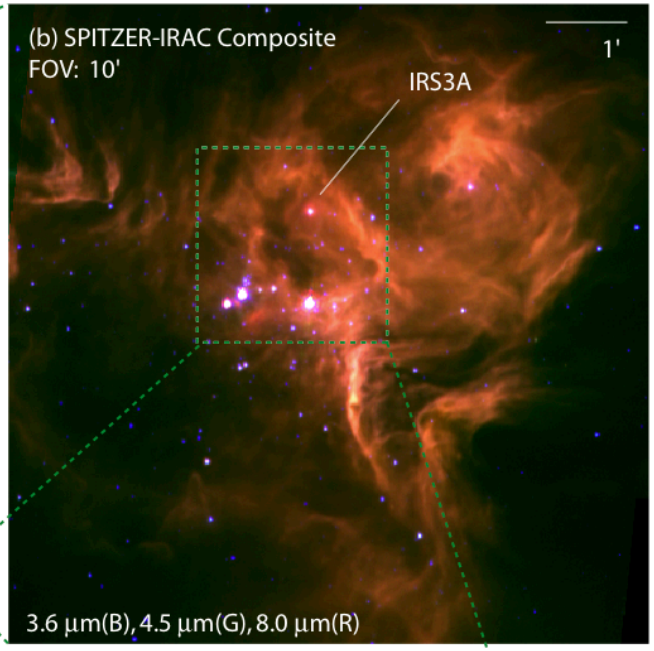
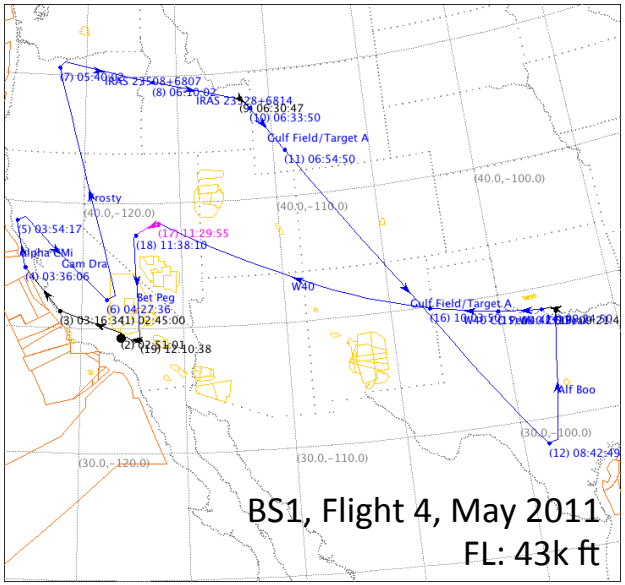
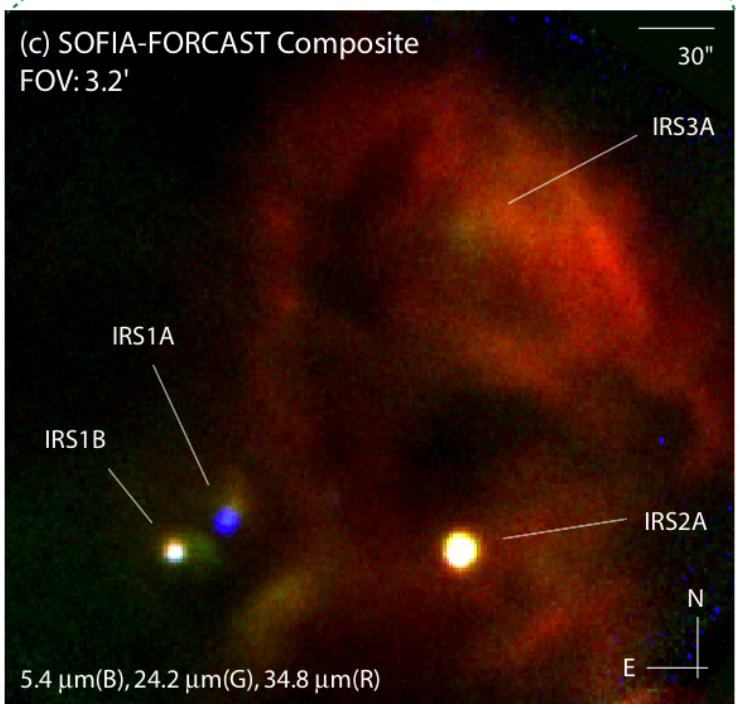




Mid-Infrared imaging of the W40 Star Forming Region using SOFIA-FORCAST

(Shuping & Vacca, Basic Science Program 81_0067)





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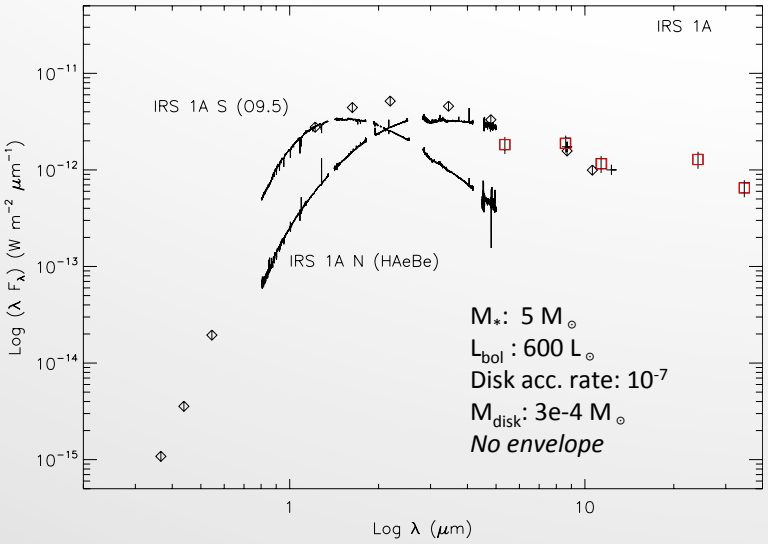
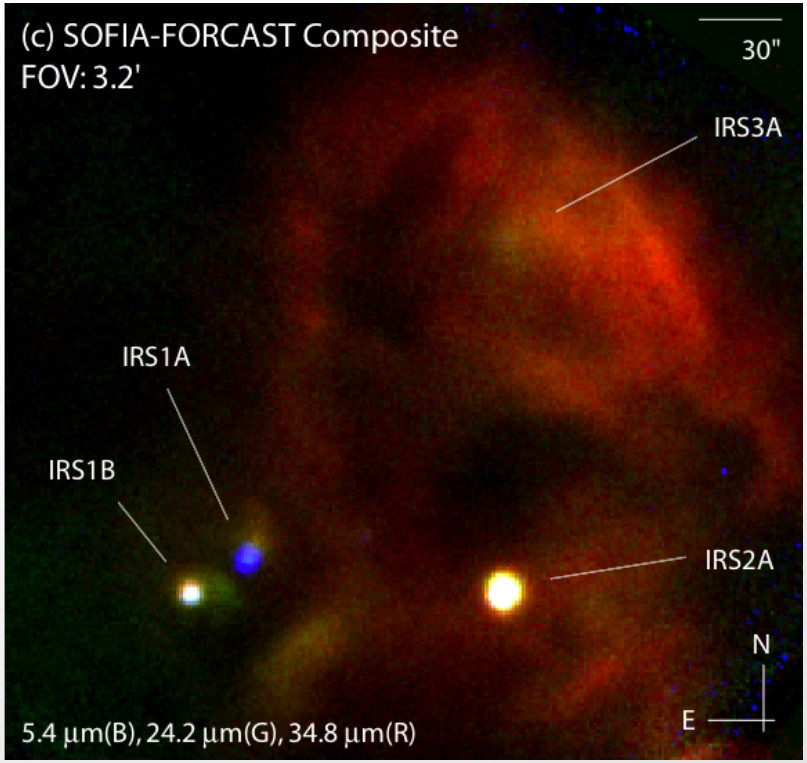
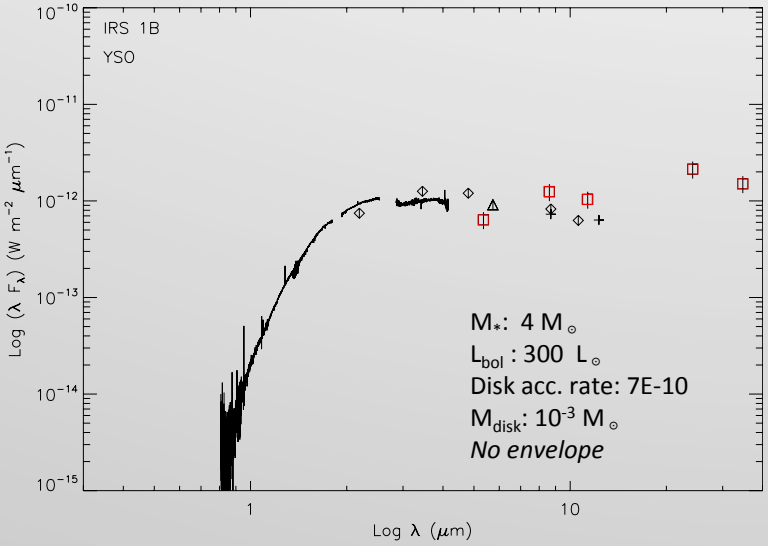
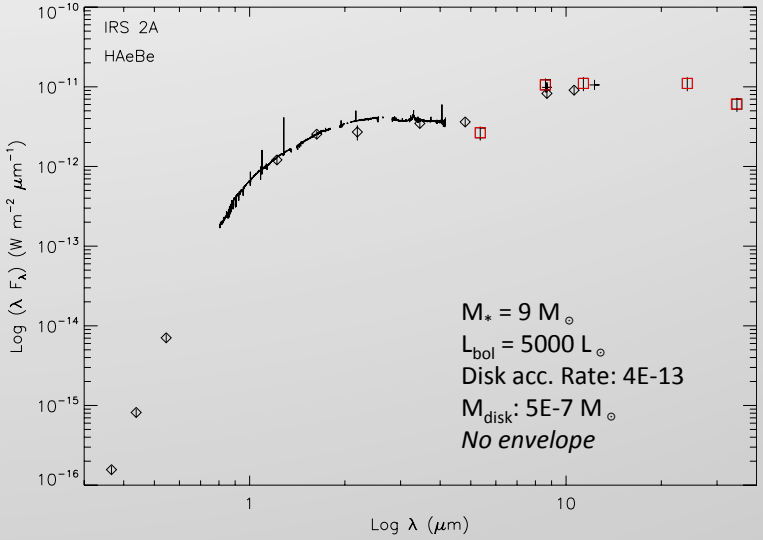




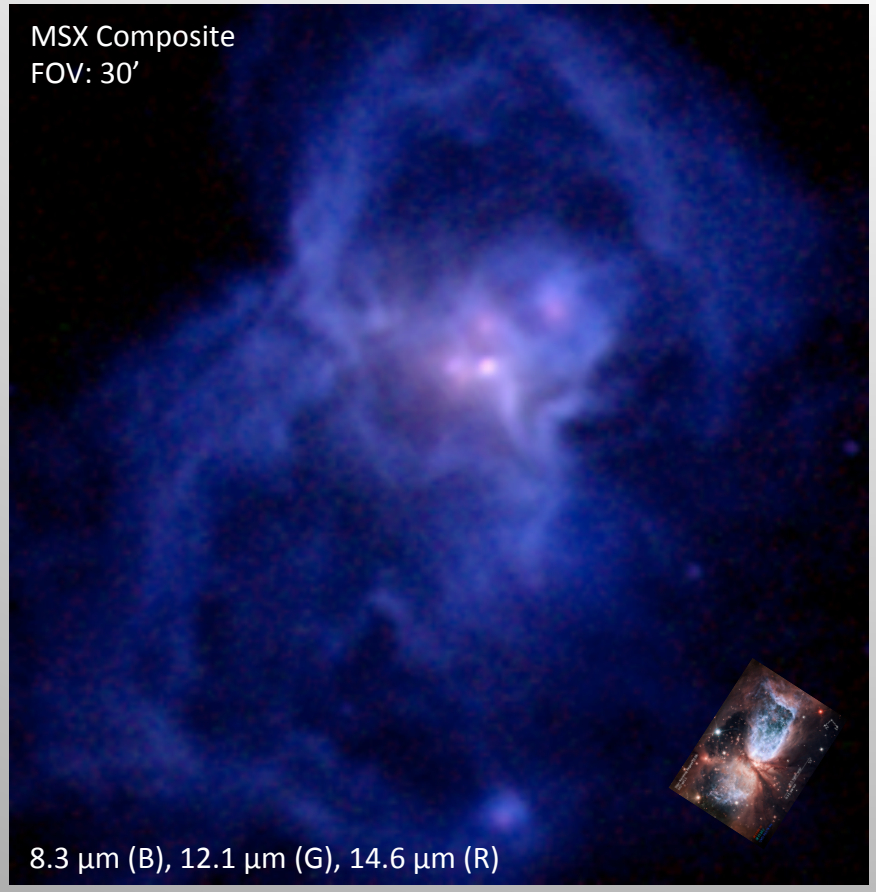




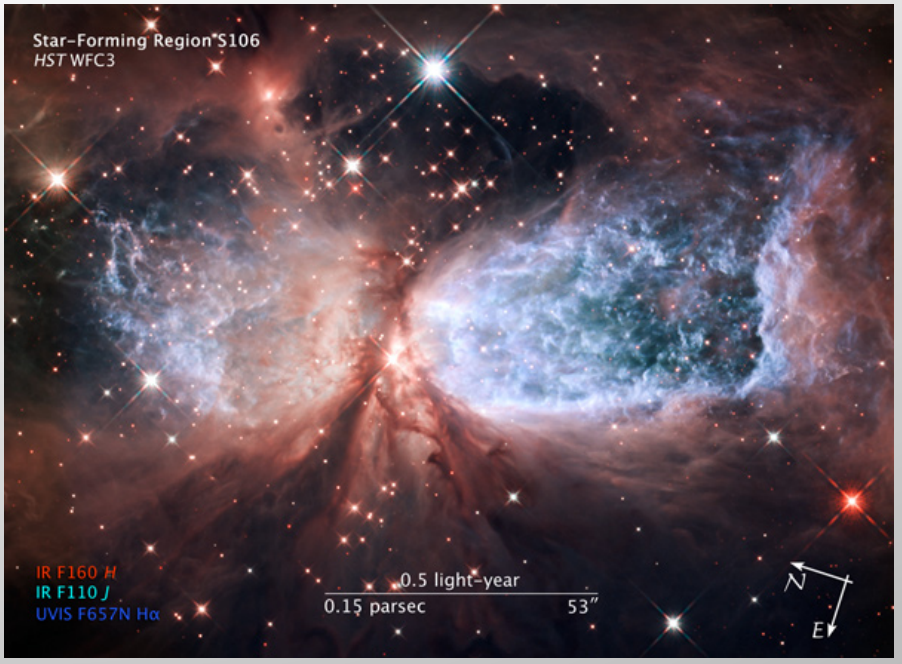
Selected nearby embedded clusters (< 1 kpc).
(Lada & Lada 2003)

Name	D (pc)	Size (pc)	N_*	Stellar Mass ($M_\odot$)	Core Mass ($M_\odot$)	SFE
ρ Oph	125		100	53	550	0.09
S 106	600	0.3	160	120		
IC 348	320	1.0	300	160		
NGC 2024	400	0.88	309	180	430	0.33
NGC 2264	800		360	330		
Mon R2	800	1.85	371	340	1000	0.25
Cep A	700		580	310		
W40	**500**	**< 2.4**	**~600**			
W40 (YSOs)	**500**	**< 0.9**	**113**	**~55**	**310**	**0.15**
Trapezium	450	0.24	780	413		
ONC	450	3.8	1740	1100		

W40



S106



W40 Star Forming Region

- 1 late-O, 3 early-B
- Bipolar nebula (d = 4 pc)
- 600 members
- Cluster Size: 2.5 pc
- Age: < 3 Myr

S106 Star Forming Region

- 1 late-O/early-B
- Bipolar nebula (d = 0.7 pc)
- 200 members
- Cluster Size: 0.3 pc
- Age: < 0.2 Myr

Future Work

- **Mid-IR spectroscopy of bright YSOs using FORCAST Grisms**
  - Disk dust/gas properties; geometry.
- Cluster census using Spitzer IRAC/MIPS archive data
  - Improve disk fraction determination and low-mass stellar membership
- Jets/outflows?
- Dense sub-cluster surrounding IRS 1A South (O9.5)
  - >15 stars w/in 15000 AU